Energy savings in motor systems – experience from Switzerland

streamSAVE webinar
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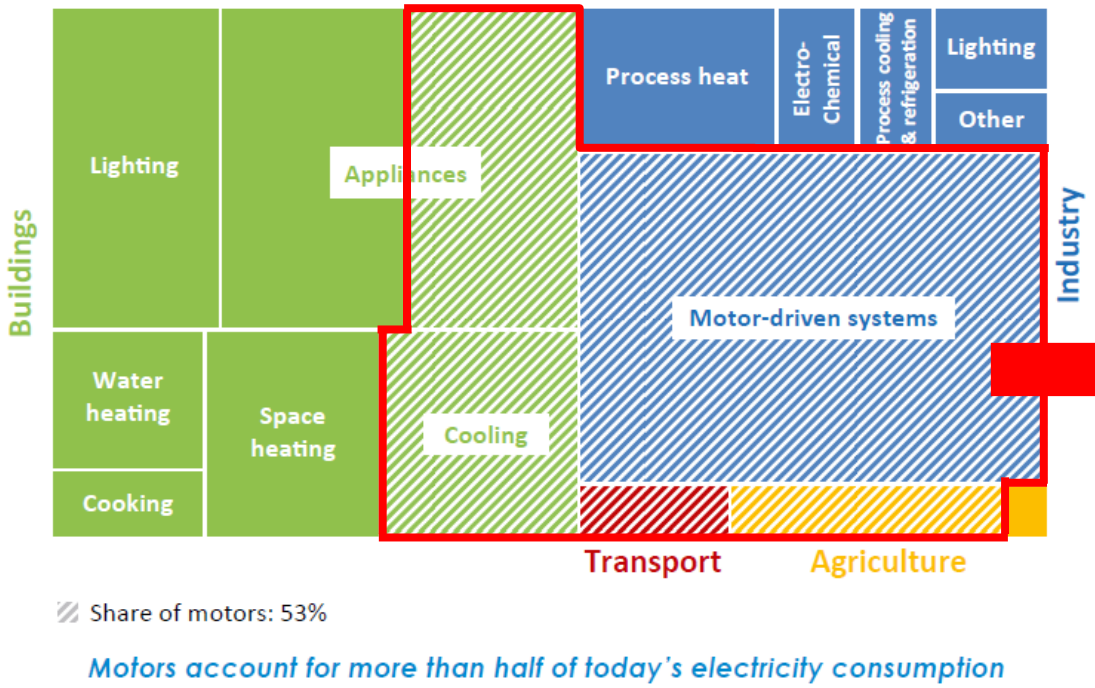
Overview

- Background: motor systems
  - Consumption
  - Lifetime
  - Savings potential
  - Challenges
- Situation in Switzerland
- Swiss experience 2010 – 2021
- Calculation methods
- Concluding remarks

Motor systems

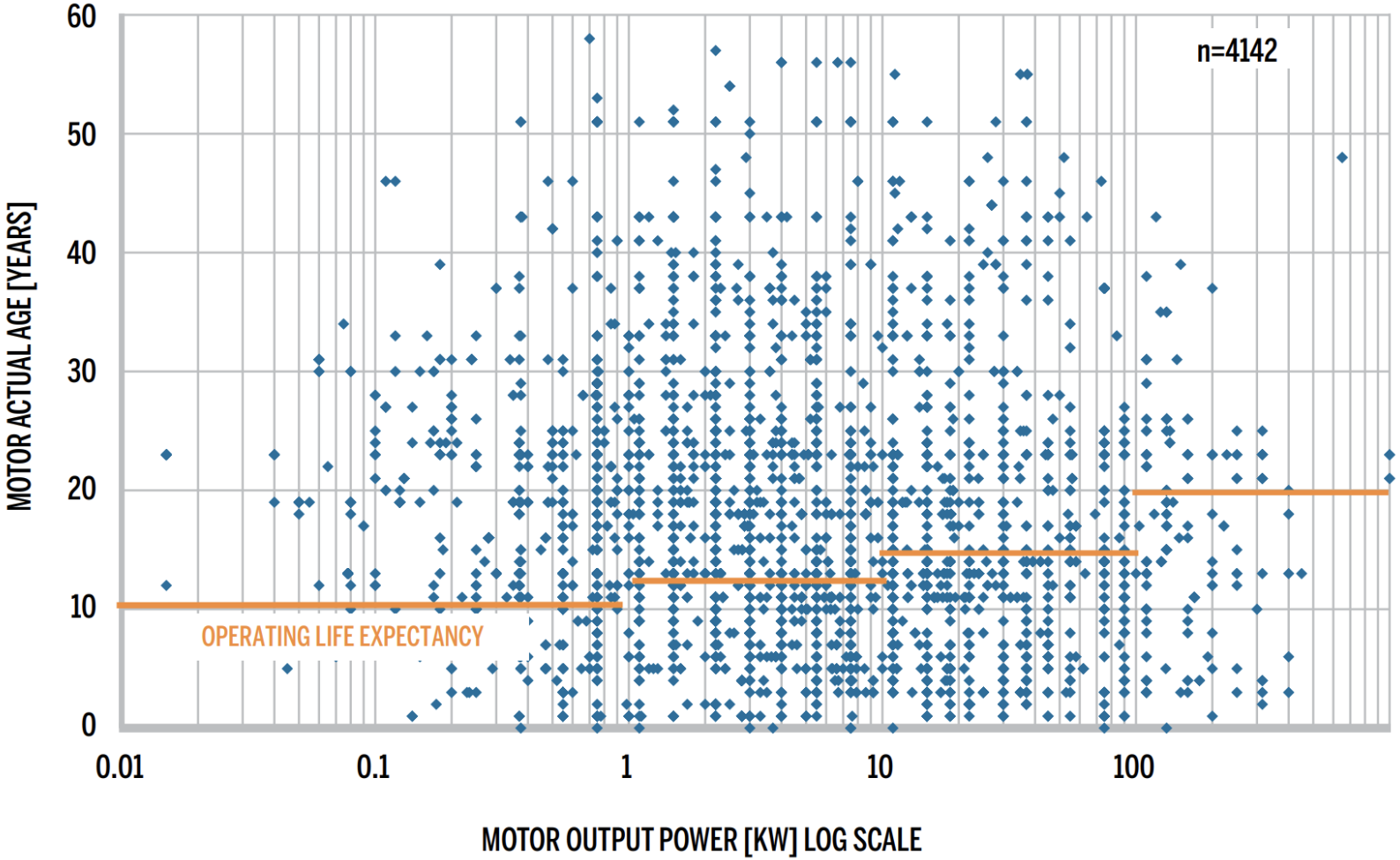
Figure 7.9 ▷ **Global total final electricity consumption by end-uses, 2014**



Motors represent 74% of electricity consumption in industry
Source: IEA World Energy Outlook, 2019

Motors are mainly used in industry, large buildings and infrastructure systems. Also transport, agriculture and household appliances include motors.
Source: IEA World Energy Outlook, 2016

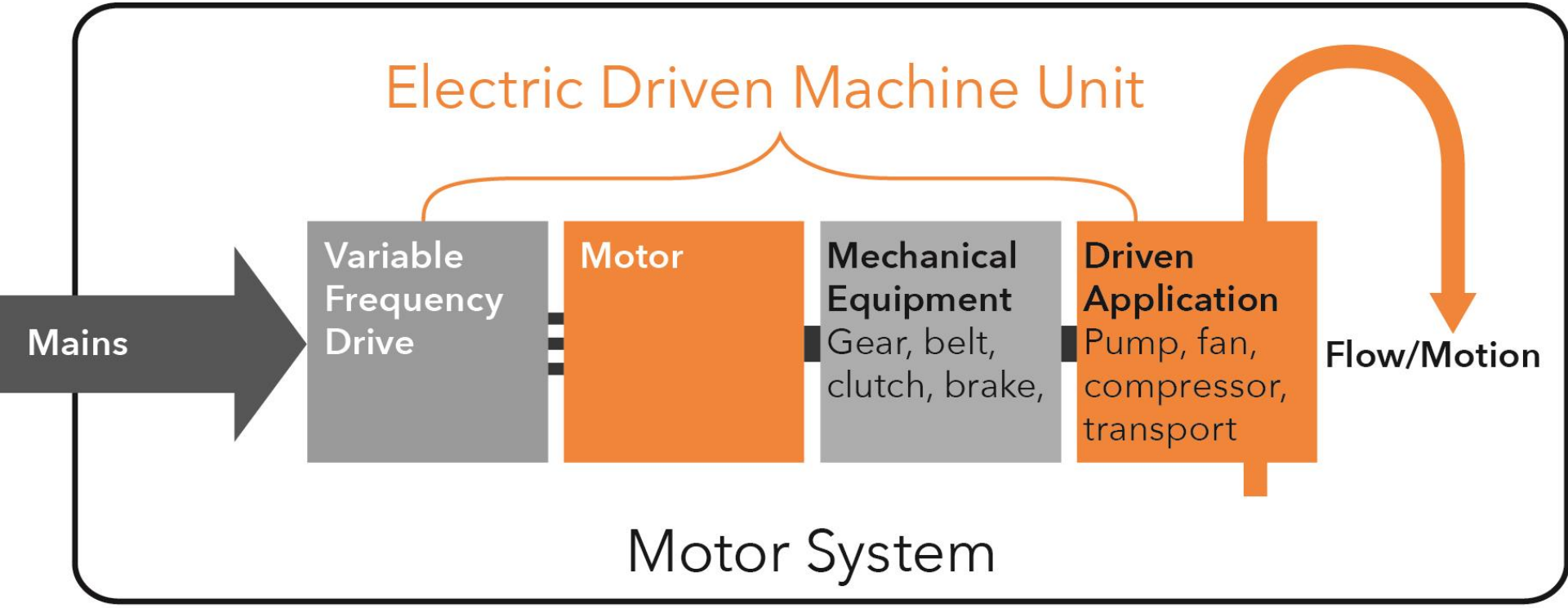
Motors get twice as old as their expected operating life!



Source: Swiss Agency for Efficient Use of Energy, 2012

Savings potential

Average savings potential on system level: 20 – 30%



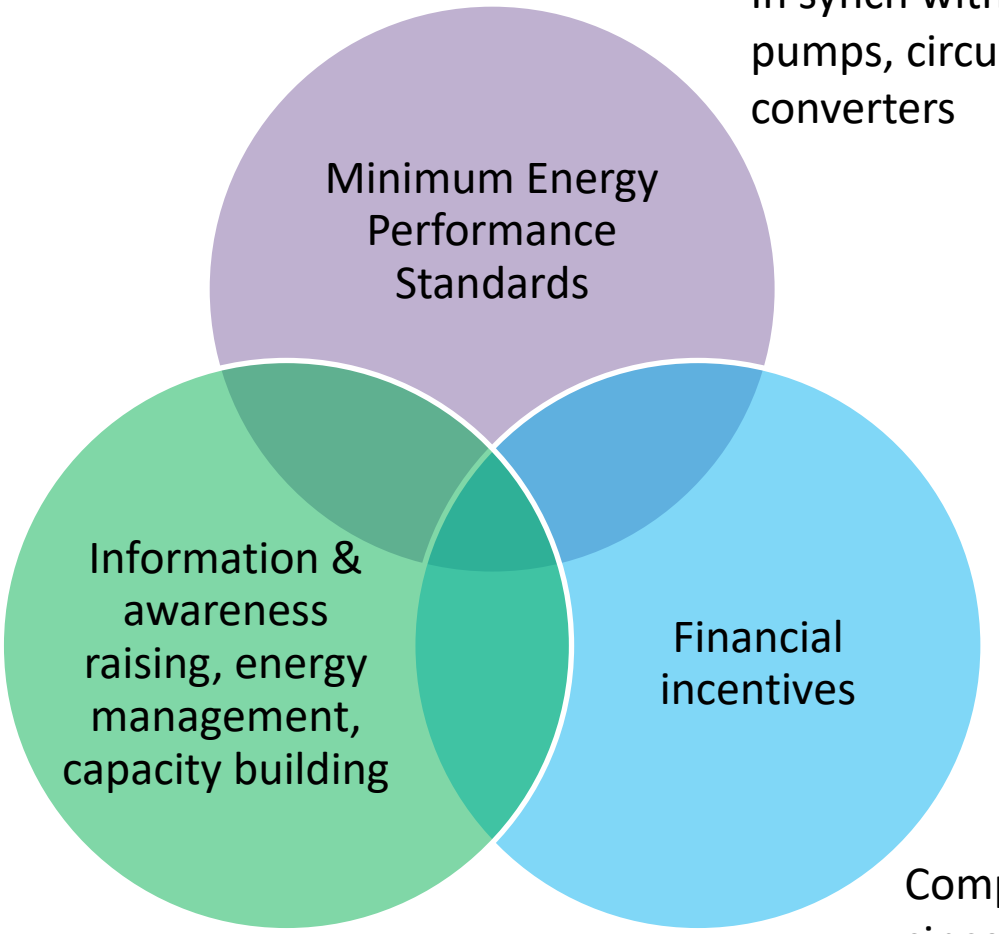
$$\eta_{System} = \eta_{VFD} * \eta_{Motor} * \eta_{Gear} * \eta_{Belt} * \eta_{Driven\ application}$$

Challenges: many

1. Motor systems are complex and require robust technical know-how
2. Necessary internal efficiency know-how is seldom available -> external experts, training of personnel
3. Confidentiality issues: factory doors are hard to open
4. Never touch a running system! Who takes the responsibility if something goes wrong when optimising the system?
5. Dependence on few suppliers, customer-binding through service and maintenance contracts (with guarantees)
6. Purchase price vs. life cycle cost and split incentives
7. Cost of energy: so far too low
8. Other multiple benefits drive optimisation measures (e.g. reliability of equipment, more uptime, less breakdowns, etc.)

Situation in Switzerland

In synch with the EU: for motors, pumps, circulators, fans, frequency converters



Topmotors, conferences, webinars, continued education programme, target agreements for companies

Competitive tenders since 2010

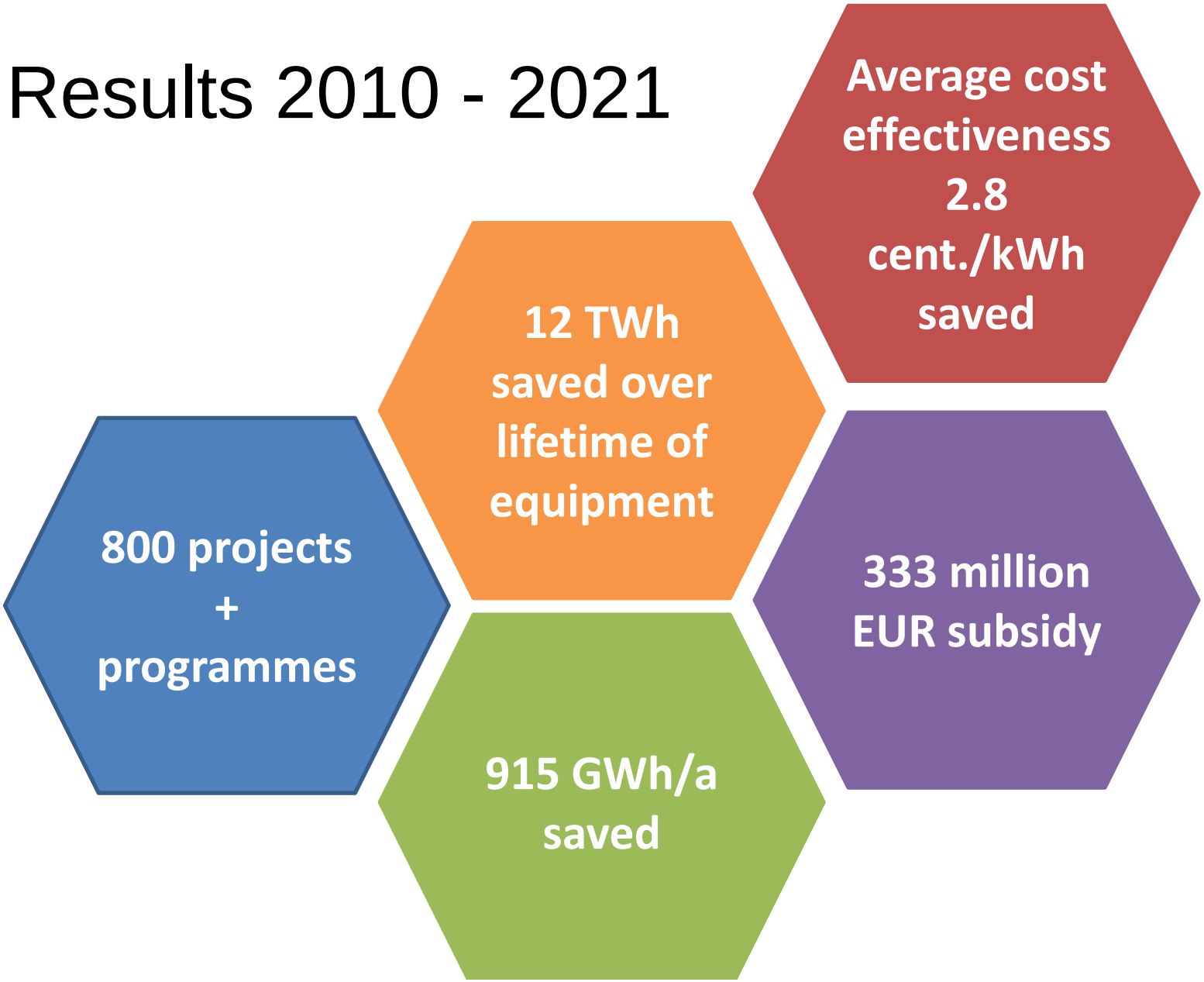
Swiss competitive tenders

- **Period**: annually since 2010
- **Goal**: saving electric energy
- **Sectors**: household, industry, services
- **Budget**: ca. 50 Mio. EUR/year
- **Procedure**: tender for
  - projects (continuous): one project in own facility
  - programmes (1x per year): several projects combined, for third-parties
- **Criteria**: cost effectiveness

$$\frac{\text{amount of subsidy [CHF]}}{\text{amount of energy saved over lifetime of equipment [kWh]}}$$

- **Subsidy**: max. 30% of investment costs
- **More info**: www.prokw.ch

Results 2010 - 2021



Source: www.bfe.admin.ch/bfe/de/home/foerderung/energieeffizienz/wettbewerbliche-ausschreibungen-prokilowatt.exturl.html/aHR0cHM6Ly9wdWJkYi5iZmUuYWRtaW4uY2gvZGUvcHVibGljYX/Rpb24vZG93bmxvYWQvODQyMA==.html

Calculation of final energy savings

$$TFES = n \cdot P_n \cdot h \cdot \left(\frac{1}{\eta_c} - \frac{1}{\eta_{he}}\right) \cdot LF \cdot 100$$

Additional savings in case of the installation of a variable speed drive:

$$TFES_{VSD} = n \cdot \frac{P_n}{\eta_{he}} \cdot 100 \cdot h \cdot f_{VSD}$$

TFES	Total final energy savings [kWh/a]
n	Number of motors replaced [dmnl]
P_n	Nominal power as indicated in the nameplate [kW]
h	Annual operating hours [h]
η_c	Efficiency of conventional motor [%]
η_{he}	Efficiency of high-efficiency motor [%]
LF	Load factor [dmnl]
f_{VSD}	Factor to account for additional savings generated by the installation of a variable speed control (VSD) [dmnl]

Source: streamSAVE motors methodology

Swiss calculation method

- Annual electric energy saving:

$$\Delta E_a \left[\frac{kWh}{a}\right] = \left(E_{\text{old equipment}} - E_{\text{new equipment}} \right) \left[\frac{kWh}{a}\right]$$

- Electric energy saving over lifetime of equipment:

$$\Delta E_N\ [kWh] = 0{,}75 * N_S[a] * \Delta E_a \left[\frac{kWh}{a}\right]$$

ΔE_N: electric energy saving over lifetime of equipment

0.75: factor to account for savings that would have occurred through natural replacement rate*

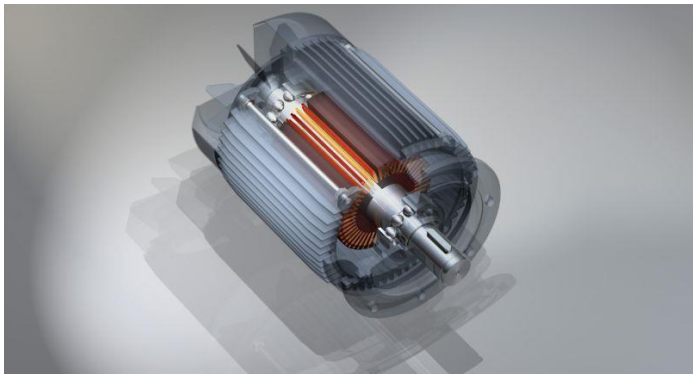
N_S: standard lifetime of equipment (*Nutzungsdauer*)

Could be considered as a 'penalty' for not overestimating savings

Source: https://www.bfe.admin.ch/bfe/de/home/foerderung/energieeffizienz/wettbewerbliche-ausschreibungen-prokilowatt.exturl.html/aHR0cHM6Ly9wdWJkYi5iZmUuYWRtaW4uY2gvZGUvcHVibGljYX/Rpb24vZG93bmxvYWQvMTExNTY=.html

Electric motor specifics

- Standard lifetime:
  - Baseline: **15 years**
    (also when a motor is part of a system e.g. compressors)
  - For motor replacement, in case of motors above 20 kW: **25 years**
- Only motors above the current Minimum Energy Performance Standards can be subsidised:
  - 0.12 kW - 0.75 kW: IE3 or better
  - 0.75 kW - 1000 kW: IE4 or better



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Concluding remarks

- Motors: important, **motor systems** even more important
- What triggers early motor replacement?
  Experience shows it does not happen by itself.

What measures could be implemented to boost early motor replacement?

1. **Understanding** the motor stock and its characteristics (EU-wide study)
2. **Awareness raising** among end-users (multiple or non-energy benefits)
3. Create **alliances** with different stakeholders (manufacturers, service companies, end-users, policy makers, etc.)
4. **Capacity building** for qualitative energy audits (including motor systems)
5. **Subsidies**

Subsidies – final thoughts

- Ideally: subsidy is a compensation for the additional cost of the more energy efficient solution
- Free rider effect: estimated at around 25%*
- Low hanging fruits vs. system optimisation
- Reward early replacement, e.g.
  - x%: if replaced equipment exceeded its lifetime
  - 2x%: between 50% and 100% of its lifetime
  - 3x%: below 50% of its lifetime

Source: https://guidehouse.com/-/media/www/site/downloads/energy/2019/navigant-efk-2019-evaluation-foerderprogramme.pdf

Questions?

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